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Veterinary problems of endurance horses in England and Wales

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Abstract

Several studies have shown that a considerable proportion of horses are eliminated from endurance rides due to lameness and metabolic problems. Limited information is available on specific veterinary issues in endurance horses and there are no descriptive data on veterinary problems in a large population of endurance horses. The aim of this study was to describe veterinary problems occurring in endurance horses in England and Wales, the regions of the United Kingdom where endurance rides are organised and regulated by Endurance Great Britain (Endurance GB). A comprehensive online self-completed questionnaire was used for data collection (30th December 2015-29th February 2016) All members of Endurance GB who were the main rider of one or more endurance horses were eligible to participate. From the target population of 1209 horses, 190 questionnaires were completed by riders, resulting in a 15.7% response rate. The most common rider-reported veterinary problem was lameness, affecting 152/190 (80.0%) of endurance horses at some point during their careers and 101/190 (53.2%) of horses in the previous 12 months. Detailed information on the most recent episode of lameness was available for 147 horses. Seventy-six percent of these lameness episodes (112/147) had been initially identified by a veterinarian, but only 52% of these lameness episodes were investigated further by a veterinarian, despite the high proportion of horses affected by lameness and the proportion of horses with recurrent lameness episodes. The second most common veterinary problem was thoracolumbar region pain, followed by non-specific cough, skin disease and colic. Education of endurance riders may improve the number, quality and timing of veterinary investigations, especially for lameness and thoracolumbar region pain.

Introduction

The popularity of endurance riding has been growing worldwide (Fédération Equestre International [FEI] Endurance Report 2015). However, there are limited evidence-based data

available on veterinary problems of endurance horses. Several studies have investigated reasons for eliminations from endurance rides (Burger and Dollinger, 1998; Langlois and Robert, 2008; Nagy et al. 2014a, 2014b; Younes et al. 2016). The most common reason for elimination is lameness, followed by elimination for metabolic reasons (Burger and Dollinger, 1998; Langlois and Robert, 2008; Nagy et al. 2014a, 2014b; Younes et al. 2016). In the largest-scale global study of 30,741 horse starts at FEI competitions, 30.0% of started horses were eliminated for lameness and 8.7% for metabolic reasons (Nagy et al. 2014a). Specific injuries are described in textbooks and in case series, but most of these data are based on personal experiences and anecdotal information (Misheff, 2010; Holbrook, 2011) or do not provide information about the prevalence of the studied problem in the endurance horse population (Misheff et al., 2010; Fraipont et al., 2011). To our knowledge only two studies have investigated the prevalence of veterinary problems in endurance horses. The prevalence of gastric ulceration was described in a relatively small population of 30 endurance horses; squamous gastric ulcers were diagnosed in 93.3% of horses in the competition season and in 48% in the between-season period (Tamzali et al., 2011). Exertional rhabdomyolysis (based on serum creatine kinase activity and not on clinical signs) was reported in 4/68 (5.9%) endurance horses competing in an 80.5 km endurance ride in the North Western United States (Wilberger et al., 2015). No descriptive epidemiological data have been published on general veterinary problems in endurance horses. The aim of this study was to describe veterinary problems occurring in endurance horses in England and Wales, the regions of the United Kingdom where endurance riding is regulated by Endurance Great Britain (Endurance GB).

Material and methods

An online survey was designed using dedicated software (SurveyMonkey[1]). Questions regarding the horses' and riders' signalment and competition record, husbandry, equine

[1] SurveyMonkey Inc., Palo Alto, USA

65 nutrition and training practices, veterinary problems and veterinary care were included. A large
66 amount of the data was acquired to provide feedback to riders on common husbandry, nutrition
67 and training practices in England and Wales, and not as a part of this study. The full
68 questionnaire included 217 questions, 104 of which were used for the current study. Those
69 horse, rider and training-related variables that are relevant to this study are presented in Table
70 1. Veterinary information included questions on whether the horse had ever suffered from the
71 conditions listed. Detailed information on the most recent episode of lameness, back pain, colic
72 and exertional rhabdomyolysis was also collected (Table 2).
73 All members of Endurance GB that were registered with Endurance GB in 2015 and were the
74 main rider of one or more horses registered with Endurance GB (n=1209 horses) were eligible
75 to participate in the study. Riders could complete the questionnaire for a maximum of two
76 horses. Riders were notified about the survey by Endurance GB via social media and email.
77 The survey was open between the 30th December 2015 and 29th February 2016. Data were
78 exported from the questionnaire software into an Excel spreadsheet. The study was approved
79 by the Clinical Research Ethics Committee of the Animal Health Trust (AHT 41 2015).
80 Statistical analyses were performed using a dedicated statistical software (SPSS Version 22[2]).
81 Normality of the data was assessed using a Shapiro-Wilks test. Descriptive analysis was carried
82 out for continuous variables and included calculation of the mean (± standard deviation) or
83 median (and interquartile range [IQR]) (depending on whether or not the data were normally
84 distributed), minimum and maximum values. All continues variables were categorised.
85 Frequencies of categorical values were summarised. Chi-squared tests were used to assess
86 differences in proportions between categorical rider-, horse-, and training-related variables and
87 the outcomes of lameness and back pain (in the 12 months preceding data collection or any
88 time in the horse's career), which were retrospectively selected as the two most common rider-

[2] IBM SPSS Statistics Version 22, IBM, USA

reported veterinary problems. Initially statistical significance was set at $p<0.05$. To adjust for multiple testing (25 variables for each outcome), Bonferroni correction was used and results were re-assessed considering $p<0.002$ as significant.

Results

A total number of 258 responses were received for the 1209 eligible horses. Only surveys that included answers to all veterinary-related questions were included. After exclusion of incomplete surveys (surveys that did not have an answer to every veterinary-related question), completed datasets were available for 190 horses, resulting in a response rate of 15.7%. The number of riders who completed questionnaires for two horses is not known. However, after careful assessment of the data, it appears that a maximum of 11 riders may have completed the questionnaire for two horses.

Details on riders and horses

Age, gender and weight of riders are summarised in Table 3. Most riders (130/190, 68.6%) had experience in rides of 80 km or longer distance, although only 62/190, 32.6% had participated in FEI rides.

The majority of horses (184/190, 96.8%) had been ridden by the current rider for more than one year. The horses' age, gender, breed, weight and height are presented in Table 3. The median weight of the horses was 450 kg (IQR 80), however, the weight of only 50/190 (26.3%) of horses had been established using a weighbridge (i.e., could be considered accurate).

Training

Approximately 80% of horses (153/190) were ridden by only one rider. The majority of horses (182/190, 95.8%) were ridden 1-5 times a week (65/190 [34.2%] 1-3 times a week, 64/190 [33.7%] 4 times a week and 53/190 [27.9%] 5 times a week). The longest training session of the week was 6-20 miles (9.6-32 km) for 91.6% of horses (174/190). Most horses (158/190, 83.1%) did canter work 1-3 days a week and the most common canter distance during a training

session was 1-3 miles (1.6-4.8 km) (108/190, 56.8%). The speed of the fastest canter work of a typical week varied greatly, from <15 km/hr to >25 km/hr. Although riders had the option to choose 'not measured', no information was obtained on whether speed was measured using a global positioning system or by establishing speed from the distance covered and elapsed time. There was a great variation in the terrain on which regular endurance training was carried out. The most common going horses were trained on was a mixture of hard and soft surfaces (104/190, 54.7%). Most horses (84/190, 81.1%) were regularly ridden on asphalt as a part of their training (in addition to road crossings). Nearly 40% of horses (74/190) were trained in disciplines other than endurance at the time of, or in the year preceding, data collection. The most popular discipline was dressage (59/190, 31.1%), followed by show-jumping (31/190, 16.3%).

The most common veterinary problems

Veterinary problems affecting ≥5% of horses at least once in the past 12 months or at any time in their career are shown in Figure 1. The most frequently occurring veterinary problem was lameness. Eighty percent (152/190) of horses had been lame at least once in their career; 51/190 (26.8%) horses had been lame once, 76/190 (40.0%) two or three times and 25/190 (13.2%) four times or more. In the 12 months preceding completion of the survey, 101/190 (53.2%) of horses had suffered from at least one episode of lameness; 21/190 (11.1%) had been lame once, (37/190, 19.5%) two or three times and 43/190 (22.6%) four times or more. Forty percent of horses (76/190) had been eliminated for lameness from an endurance ride at some stage during their career.

The speed of the fastest canter work in training was tested for association with lameness: horses that had a maximum canter training speed of 20.1-25 km/hr during their training were more likely to have been lame in the past 12 months than horses that had a maximum canter training speed slower than 20.1 km/hr or faster than 25 km/hr ($p=0.016$). Horses that underwent

dressage training were more likely to have experienced lameness in the past 12 months than horses that did not receive dressage training (p=0.001).

Thoracolumbar region pain was the second most common veterinary problem (67/190, 35.2%). However, in only three horses did thoracolumbar region pain result in elimination from an endurance ride. Thoracolumbar region pain was more than twice as likely to be recognised in the past 12 months in horses that had their saddle fitted in the last six months than in horses whose saddle had been fitted over six months ago (p=0.016). No rider- or horse- -related factors were found to be significantly associated with lameness or thoracolumbar region pain (P>0.05). The number of horses reported to have suffered from other conditions was too small for meaningful statistical analysis.

Less commonly reported veterinary conditions affecting <5% of horses included muscle disease other than rhabdomyolysis, gastric ulcers, laminitis, cardiac arrhythmias, nose bleed, recurrent airway obstruction, respiratory noise and synchronous diaphragmatic flatter.

The most recent episode of lameness

Information on the most recent episode of lameness was available for 147 horses. In 85/147 (57.8%) horses the most recent episode of lameness resulted in elimination from an endurance ride. In 67/147 (45.6%) horses the most recent episode of lameness was first noted during the ride, in 18/147 (12.2%) within 24 hours after the ride and in four horses >24 hours but within one week after the ride. In the remaining horses the most recent episode of lameness was first recognised in training. The most commonly identified lame limbs were the left forelimb (47/147, 32.0%) and the right hindlimb (43/147, 29.3%), followed by the right forelimb (37/147, 25.2%) and left hindlimb (22/147, 15.0%). Most horses (132/147, 89.8%) were lame on one limb and seven horses were lame on two limbs. One horse was lame on all four limbs. In seven horses the lame limb was not identified or the rider did not remember.

Approximately 76% of these lameness episodes (112/147) were diagnosed by a veterinary surgeon; in the remainder the lameness was recognised by a farrier, physiotherapist, trainer, rider or a chiropractor. Approximately half of the recent lameness episodes (76/147 [51.8%]) were investigated by a veterinarian. Immediate veterinary consultation was sought in 17/76 (22.4%) cases that were investigated. The other horses were rested before the veterinary assessment, 33/76 (43.4%) for <1 week, 5/76 (6.6%) for 1-2 weeks and 21/76 (27.6%) for >2 weeks.

Diagnostic analgesia was used in only 17/76 (22.4%) of lameness investigations. Radiographic examination was performed in 25/76 (32.9%) horses, ultrasonographic examination in 24/76 (31.6%), scintigraphy in 6/76 (7.9%) and magnetic resonance imaging in three horses.

The most common veterinary diagnosis of lameness was tendon or ligament injury (16/76, 21.1%), followed by foot pain (15/76, 19.7%) and joint pain (10/76, 13.2%). Other diagnoses included sacroiliac pain in two horses and stress fracture of the proximal phalanx in one horse. In 11 horses (14.5%) no diagnosis was achieved. A variety of treatments was used, including analgesic medication, physiotherapy, intra-articular medication, remedial farriery, shock-wave therapy, chiropractic treatment and surgery. Numbers in different injury groups were too small to evaluate association with specific treatment. In 40/76 (52.6%) of lameness cases diagnosed by a veterinarian, no treatment (other than rest) was used. Sixty percent (46/76) of horses had less than one month off training due to the most recent episode of lameness. Ten horses (13%) were rested for 1-2 months, 9/76 (12%) for >2 to 6 months and 10/76 (13%) for >6 months.

<u>The most recent episode of thoracolumbar region pain</u>

Detailed information on the most recent episode of thoracolumbar region pain was available for 56 horses. In 24/56 (42.9%) horses thoracolumbar region pain was first noted during or within 24 hours after an endurance ride. However, in only three horses did the most recent episode of thoracolumbar region pain result in elimination from an endurance ride. The most

188 recent episodes of thoracolumbar region pain were most frequently recognised by a
189 physiotherapist (19/56, 33.9%) and by the rider (16/56, 28.1%); a diagnosis was made by a
190 veterinarian in only 17.9% (10/56) horses. Other people recognising thoracolumbar region pain
191 included chiropractors, osteopaths, and a farrier. Veterinary investigation of the thoracolumbar
192 region pain was carried out in only 15/56 (26.8%) horses. Radiography was used in three
193 horses, ultrasonography in one horse and scintigraphy in another. Veterinary diagnoses
194 included thoracolumbar region pain related to an ill-fitting saddle (six horses), muscle pain
195 (four horses), impinging spinous processes (two horses), spondylosis (one horse) and
196 osteoarthritis of the thoracic articular process joints (one horse). The most commonly used
197 treatment of thoracolumbar region pain was physiotherapy (31/56, 55.4%), followed by
198 chiropractic treatment (14/56, 25.0%) and fitting or changing the saddle (13/56, 23.2%).
199 The most recent episode of colic
200 Detailed information on the most recent episode of colic was available for 21 horses. In one
201 horse the last episode of colic resulted in elimination from an endurance ride. In 6 other horses
202 (6/21, 28.6%) colic was noted within 24 hours after an endurance ride. In 14/21 (66.7%) of the
203 horses a diagnosis of spasmodic colic was made; one horse had an impaction, one horse had a
204 uterine infection resulting in colic symptoms and in five horses no specific diagnosis was
205 achieved. Seventeen horses (81.0%) were treated with analgesics and intravenous fluids and
206 four horses (19.0%) recovered without treatment. The majority of horses only had a short time
207 off training due to the most recent episode of colic (10/21, 47.6%: <1 week; 7/21, 33.2%: 1-2
208 weeks). Two horses had >2 but less than 4 weeks off, one horse 1-2 months and one horse >2
209 months but <6 months.
210 The most recent episode of exertional rhabdomyolysis
211 Detailed information on the most recent episode of exertional rhabdomyolysis was available
212 for 20 horses. In 6/20 (30.0%) horses the last episode of exertional rhabdomyolysis resulted in

elimination from an endurance ride. In seven horses the last episode of exertional rhabdomyolysis was related to an endurance ride: three horses (15.0%) developed symptoms during the first half of the ride, one during the second half of the ride, two immediately after finish and one not immediately, but within 12 hours of finishing the ride. The urine was reported as discoloured in 13/20 (65.0%) horses. Six horses (30.0%) presented with mild stiffness, 13/20 (65.0%) horses were moderately stiff and unwilling to move and one horse was recumbent. A blood test was used and confirmed the diagnosis in 13/20 (65.0%) horses and muscle biopsy was performed in one horse. Ten horses (50.0%) received analgesic medication, two horses received intravenous fluids and analgesic medication and 8/20 (40.0%) recovered without treatment. Thirteen horses (65%) had <1 month off work due to the most recent episode of exertional rhabdomyolysis; two horses were rested for 1-2 months, three horses for >2 to 6 months and one horse for >6 months.

Discussion

This is the first study to provide descriptive data on common veterinary problems in a population of endurance horses. A relatively small response rate was achieved (15.7%). In a previous study using a similar sized population of endurance riders and paper questionnaires, a comparable 18.8% response rate was documented (236 questionnaires for 1256 competition starts) (Nagy et al. 2013). In the current study an online questionnaire was used and riders could complete the survey over a two month period. Despite the easy accessibility and the long available time, the number of responses is likely to have been limited by the time required to complete the questionnaire. Although numbers were considered too small for robust statistical analysis (e.g., multivariable logistic regression), valuable descriptive information has been gained that can be used for education of endurance riders and as a base for future studies.

Over 90% of respondents (riders) were female. Nearly 89% of Endurance GB members are female (data obtained from Endurance GB); therefore the respondents' gender distribution is a

238 good representation of Endurance GB members. No detailed age data of Endurance GB riders
239 are available, therefore a potential age-related bias cannot be excluded. Two previous studies
240 on endurance horses collected data using a rider-based questionnaire (Nagy et al., 2013;
241 Wilberger et. al, 2015). The study by Nagy et al. (2013) was international; however, 80.9% of
242 respondents were British. In that study, 80.5% of respondents were female, and the median age
243 of the riders was 39 years, which is lower than in the current study. Wilberger et al. (2015) did
244 not collect data on riders. In the current study the majority of horses (97%) had been ridden by
245 the current rider for longer than a year; therefore the riders were expected to have good
246 knowledge of their horses and to provide reliable information.

247 Lameness

248 Lameness was by far the most common veterinary problem. This is in agreement with studies
249 in other equestrian disciplines; however, the prevalence of lameness in endurance horses seems
250 to be much higher than in dressage horses or elite show-jumpers (Murray et al., 2010; Egenvall
251 et al., 2013). In the current study, 80% of endurance horses had been lame at least once during
252 their career. In a study investigating veterinary problems in dressage horses using an owner-
253 based questionnaire 33% of dressage horses had been lame at some point during their career
254 and 24% of these within the previous two years (Murray et al. 2010). An international study
255 that investigated days lost to training and competition in elite show-jumpers concluded that
256 77% of days lost to training and competition were due to orthopaedic injuries (Egenvall et al.,
257 2013). Nearly half of the horses (126/263, 47.9%) lost days to training or competition, but the
258 number of horses suffering from orthopaedic injuries was not specified (Egenvall et al., 2013).
259 In a study of Thoroughbred racehorses in training, lameness accounted for 81.5% and 82.6%
260 of days lost to training in two and three year old horses, respectively (Dyson et al., 2008). The
261 incidence of lameness was 15.6 and 13.6 cases/100 horse months for two and three-year-olds,
262 respectively; the number of horses affected by lameness was not available.

It is possible that lameness is more common in endurance than in dressage horses or show-jumpers, but it is also possible that the difference is due to the higher number of detected lameness episodes in endurance horses. Endurance horses are examined by veterinarians several times at an endurance ride (before, during and immediately after the ride at both national and international events), while the gait of dressage horses and show-jumpers is only examined by veterinarians before an international competition. Dressage horses are judged at competitions on the quality of their paces and regularity of rhythm, but this assessment is not done by a veterinarian. Not all endurance horses are required to work in circles and tight turns, while dressage horses and show-jumpers are. Moving in a circle (on the lunge or when ridden) can result in exacerbation of lameness and therefore easier recognition (Dyson and Greve, 2016), This may be why endurance horses that underwent dressage training were more likely to have been reported by their riders to have been lame in the past 12 months than horses that did not receive dressage training. It is possible that the prevalence of lameness in those endurance horses which do not undergo regular training in circles (e.g., dressage) is underestimated in the current study. Dressage training may have also exposed horses to additional strains resulting in lameness (Murray et al., 2006), but it is also possible that lame horses underwent dressage training following a lameness episode.

The majority of horses were ridden less frequently than horses from other work disciplines (Ely et al., 2010; Egenvall et al., 2013). National Hunt racehorses have one rest day a week on average (Ely et al., 2010). In a recent study of 263 show-jumpers, horses were rested for 10-38% of the study period; most of them for 24% of days, which equates to one to two days a week (Egenvall et al., 2013). In the current study only 27.9% of endurance horses were exercised five times a week; the remaining horses were exercised less frequently. Inadequate muscular fitness level in endurance horses might contribute to orthopaedic injury and lameness. Although it is generally believed that inadequate muscular strength can increase the risk of

orthopaedic injuries, no evidence-based study has proven this association in horses. From the current dataset no conclusions on muscular strength or fitness for a specific competition can be drawn. Only collection of daily training data (including distance and speed in each gait) in preparation for a competition would allow appropriate assessment and analysis of potential fitness for a ride of specific speed and distance.

When interpreting results of owner/rider-based questionnaires on the prevalence of lameness, it also has to be borne in mind that many lameness episodes may not be recognised by a rider. In a recent study of a general sports horse population, 231/506 (45.7%) horses in full work and perceived sound by their riders were lame or showed other gait abnormality when assessed by a veterinarian (Greve and Dyson, 2014).

Although there was some evidence of association between speed of the fastest canter work in training and lameness; these results should be interpreted with caution. The sample size was small and likely there were other contributing factors. Moreover, following Bonferroni correction, this result was not statistically significant. Exercise distance and speed (canter and gallop) have been shown to be associated with risk of fracture in Thoroughbred racehorses (Verheyen et al. 2006). In the current study no horses had sustained a fracture. Further studies are needed to assess the association between the speed of canter work and injuries in endurance horses.

Veterinary investigation was performed in a relatively low proportion of cases and was often delayed. The urgency of seeking veterinary advice may have been influenced by the severity of lameness. No information on the severity of lameness was collected. Inter-observer agreement of the severity of lameness has been shown to be poor for non-expert veterinarians and veterinary students (Arkell et al. 2006); therefore owner-reported grades or severity would be expected to be unreliable. Diagnostic analgesia was used in a surprisingly low number of lameness investigations (22%). Although there are many causes of lameness that can be

diagnosed without diagnostic analgesia (e.g., nail prick, specific tendon injuries), diagnostic analgesia is often the only way to confirm the site of pain even if apparently obvious clinical signs are present (Bassage and Ross, 2010). In the authors' experience, in many endurance horses, lameness only presents after a long distance (i.e., in competition) and improves relatively quickly with rest, only to recur when the next long distance is completed (i.e., the next endurance ride). Early investigation allows accurate diagnosis and appropriate treatment, and can determine the appropriate rehabilitation period and prognosis.

Other veterinary problems

Thoracolumbar region pain was the second most common veterinary problem. The association between recent saddle fitting and recognition of thoracolumbar region pain most likely reflects that attention was paid to the saddle in horses that had been diagnosed with thoracolumbar pain. This hypothesis is supported by a recent study on saddle fit and management using an owner-based online questionnaire, which showed a positive association between regular management of 'back problems' and a well-fitting saddle (Greve and Dyson, 2015). After Bonferroni correction the association between recent saddle fitting and recognition of thoracolumbar region pain did not remain statistically significant, however it has to be borne in mind that Bonferroni correction is likely to be conservative and may yield type 2 errors (Pernerger 1998).Although primary thoracolumbar region pain exists, thoracolumbar region pain often develops as a consequence of hindlimb lameness (Dyson 2010). An association between lameness and thoracolumbar pain has been shown in previous studies (Landman et al., 2008; Greve and Dyson, 2015a). In the current study, in none of the horses was hindlimb lameness indicated as a cause of thoracolumbar region pain; it is possible that hindlimb lameness was overlooked in some horses (Greve and Dyson, 2014).

Colic has been described in endurance horses admitted to a referral hospital within 36 hours following an endurance ride; the most common diagnosis was paralytic ileus. (Fielding et al.

2011). In the current study, none of the most recent colic episodes was related to an endurance ride. It is likely that results reflect colic in the general horse population rather than colic specific to endurance horses. In the current study, spasmodic colic was the most common diagnosis, which is in agreement with a previous study on colic in general practice (Proudman, 1992).

In seven horses the last episode of exertional rhabdomyolysis was related to an endurance ride. To our knowledge, no studies have described the clinical manifestations and the time of occurrence (the phase of the ride) of exertional rhabdomyolysis in endurance horses. In the current study 20/190 (10.5%) horses had suffered from exertional rhabdomyolysis at some stage of their career. A 4% prevalence of exertional rhabdomyolysis was documented in a study of endurance horses competing in 50 miles (80.5 km) endurance rides in the United States (Wilberger et al., 2015). Diagnosis was based on serum creatine kinase activity (> 10,000 u/L). Only one of the 4 horses showed musculoskeletal symptoms; another horse produced dark urine during the ride, but showed no other symptoms. Result of the current and Wilberger et al.'s study are not directly comparable due to the different population and sampling methods. In Thoroughbred racehorses in training, the incidence of exertional rhabdomyolysis was 6.7% during a 1-year period (McGowan et al., 2002). A similar incidence (6.4%) was reported in Standardbreds (Isgren et al., 2010). The incidence or prevalence of exertional rhabdomyolysis in other equestrian disciplines have not been published. Further studies are needed to describe the prevalence of exertional rhabdomyolysis in a larger population of endurance horses in both training and in competition and to investigate the possible underlying causes.

Limitations

Responses are likely to have been influenced by recall bias. However, most British endurance riders own/ride a small number of horses and are therefore likely to have a better knowledge of their horses and remember events from the horse's past than riders riding and competing on a large number of horses. Non-response bias might have also influenced the results. Riders of

363 horses with veterinary problems might have felt more enthusiastic to participate in a health
364 survey than riders of horses with no previous veterinary issues. Alternatively, riders might not
365 have wanted to share information about veterinary problems and therefore did not participate,
366 despite guaranteed anonymity. The number of riders who completed the questionnaire is not
367 known. Clustering may have influenced our results, potentially introducing bias. However,
368 after careful assessment of riders' characteristics, it appears that a maximum of 11 riders may
369 have completed the questionnaire for two horses. This number may be even smaller if two
370 riders shared all characteristics specified in the questionnaire. All information on veterinary
371 problems was rider-reported and therefore may not be accurate. To reduce the chance of
372 reporting self-diagnosed conditions by riders, riders were asked to report episodes of certain
373 conditions only if they had been diagnosed by a veterinary surgeon (Table 2). Riders might not
374 have been aware of all veterinary problems their horses had suffered from during their career.
375 Treatments used for the most recent episode of lameness, back pain and colic would have been
376 more informative if they could have been linked to specific diagnoses, but this was not possible
377 due to the low number of cases in each group. The questionnaire was long and time consuming
378 to complete; a greater number of responses may have been received with a reduced number of
379 questions. However, one of our aims was to provide feedback to endurance riders in the UK
380 and therefore detailed information was collected. This study was restricted to riders registered
381 with Endurance GB (the majority of them are British) and therefore results may not represent
382 endurance horses in other countries. Further studies are needed to investigate veterinary
383 problems of endurance horses in other countries and regions.
384 Detailed questions were asked on four conditions that were considered the frequent problems
385 in endurance horses based on the authors' experience. Cough and skin disease proved to be
386 included in the five most common veterinary problems and could be further investigated in the
387 future.

Conclusions

The most common veterinary problem was lameness, affecting the majority of endurance horses at some point during their careers. A surprisingly low proportion of lameness episodes were investigated by veterinary surgeons, despite the high proportion of horses affected by lameness and the proportion of horses with recurrent lameness episodes. The second most common veterinary problem was thoracolumbar region pain, followed by non-specific cough, skin disease and colic. Data on a larger number of horses are needed to assess risk factors for specific veterinary problems in endurance horses. Education of endurance riders may improve the number, quality and timing of veterinary investigations, especially for lameness and thoracolumbar region pain.

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403 **Table 1.**

404 Horse, rider and training-related variables that were considered as potential risk factors for

405 lameness and back pain in endurance horses and were tested using Chi-squared analysis.

Variables	Responses
Horse-related	
Age	Categorical
Gender	Mare, gelding, stallion
Breed	Arabian, Arabian cross, Thoroughbred or Thoroughbred cross, Warmblood, Cob-type, Pony, other
Weight (kg)	Categorical
Height (cm)	Categorical
Longest distance category the horse has competed in	≤40 km, 41-79 km, 80-100 km, 101-130 km, >130 km
Number of rides in 2015 at ≤40 km, 41-79 km, 80-100 km, 101-130 km, >130 km distances	0, 1, 2-3, 4-5, ≥6
Rider-related	
Age	Categorical
Gender	Male, female
Weight (kg)	Categorical
Weight as a % of horse's weight	Categorical
Longest distance category the rider has competed in	≤40 km, 41-79 km, 80-100 km, 101-130 km, >130 km
Highest FEI level the rider has ever competed at	CEI*, CEI2*, CEI3*, hasn't competed at FEI level
Training-related	
Training terrain	Flat, undulating, hilly, mixture
Training going	Hard, soft, deep, mixture
Frequency of ridden work	1, 2, 3, 4, 5, 6 or 7 times a week
Distance of longest training session of the week (miles)	Categorical
Frequency of canter work	1, 2, 3, 4, 5, 6 or 7 times a week
Total distance of canter work (miles)	Categorical
Speed of fastest canter work (km/h)	Categorical
Trained on asphalt	Yes, no
Fastest gait in which horse is trained on asphalt	Walk, trot, canter
Trained in other disciplines (all applicable responses could be selected)	Dressage, Show-jumping, Eventing, Racing, Driving, Trec, Other, None
Saddle fitted to the horse	Yes, no
Time since last saddle fitting	0-3 months ago, >3 to 6 months ago, 6-12 months ago, >12 months ago

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Table 2.

Variables assessed related to veterinary problems in endurance horses and detailed information on the most recent episode of lameness, colic, back pain and rhabdomyolysis. *diagnosis made by a veterinary surgeon

Variables	Responses
Health – general questions	
Veterinary condition the horse has ever suffered from: lameness, back pain, rhabdomyolysis, laminitis, polysaccharide storage myopathy (PSSM)*, muscle disease other than PSSM, colic, gastric ulcer*, diarrhoea, cough without specific diagnosis, recurrent airway obstruction*, viral respiratory infection*, respiratory noise, epistaxis, strangles, heart murmur*, cardiac arrhythmia*, synchronous diaphragmatic flutter, skin disease, other	Never, once, 2-3 times, ≥4 times
Veterinary condition the horse has suffered from in the past 12 months: Lameness, back pain, rhabdomyolysis, laminitis, PSSM*, muscle disease other than PSSM, colic, gastric ulcer*, diarrhoea, cough without specific diagnosis, recurrent airway obstruction*, viral respiratory infection*, respiratory noise, epistaxis, strangles, heart murmur*, cardiac arrhythmia*, synchronous diaphragmatic flutter, skin disease, other	Never, once, 2-3 times, ≥4 times
The most recent episode of lameness	
Resulted in elimination from a ride	Yes, no
Person who diagnosed the lameness	Veterinarian, farrier, physiotherapist, osteopath, chiropractor, trainer, rider, other
Investigated by veterinarian	Yes, no
Rested before veterinary investigation	No, yes for < 1 week, yes for 1-2 weeks, yes for > 2 weeks
Diagnostic tools	Diagnostic analgesia, radiography, ultrasonography, scintigraphy, magnetic resonance imaging, other
Lame limb	Left fore, right fore, left hind, right hind
Veterinary diagnosis	Tendon or ligament injury, foot pain, muscle problem, other, no diagnosis achieved
Treatment (all applicable responses could be selected)	Box rest, controlled exercise, turnout, analgesic medication, joint injection, shock-wave therapy, surgery, physiotherapy, osteopath treatment, chiropractor treatment, other, no treatment required
Time off training	None, < 1 week, 1-2 weeks, >2 but <4 weeks, 4 weeks to 2 months, >2 but to 6 months, >6 months
The most recent episode of back pain	
Resulted in elimination from a ride	Yes, no
Person who diagnosed the back pain	Veterinarian, farrier, physiotherapist, osteopath, chiropractor, trainer, rider, other
Investigated by veterinarian	Yes, no

Rested before veterinary investigation	No, yes for < 1 week, yes for 1-2 weeks, yes for > 2 weeks
Diagnostic tools	Diagnostic analgesia, radiography, ultrasonography, scintigraphy
Veterinary diagnosis	Impinging spinous processes, osteoarthritis of the articular process joints, muscle pain of unknown cause, ill-fitting saddle, skin sores/abrasion, other, no diagnosis achieved
Treatment (all applicable responses could be selected)	Box rest, controlled exercise, turnout, analgesic medication, local injection, shock-wave therapy, surgery, physiotherapy, osteopath treatment, chiropractor treatment, other, no treatment required
Time off training	None, < 1 week, 1-2 weeks, >2 but <4 weeks, 4 weeks to 2 months, >2 but to 6 months, >6 months
The most recent episode of colic	
Resulted in elimination from a ride	Yes, no
Person who diagnosed the colic	Veterinarian, trainer, rider, other
Veterinary diagnosis	Spasmodic colic, impaction, sand colic, twisted large colon, other, no diagnosis achieved
Treatment	No treatment, medication (including fluids), surgery, other
Time off training	None, <1 week, 1-2 weeks, >2 but <4 weeks, 4 weeks to 2 months
The most recent episode of rhabdomyolysis	
Tied up during or within 12 hours after a ride	Yes during the first half of the ride, yes during the second half of the ride, yes immediately after finishing the ride, yes not immediately after finish but within 12 hours after the ride, no
Person who diagnosed the rhabdomyolysis	Veterinarian, trainer, rider, other
Blood test used	Yes, no
Blood test (muscle enzyme activity) confirmed diagnosis	Yes, no
Urine discoloured	Yes, no
Symptoms	Mild stiffness, unwilling to move, unable to move/recumbent
Treatment	No treatment, fluids, medication, other
Time off training	None, <1 week, 1-2 weeks, >2 but <4 weeks, 4 weeks to 2 months, >2 to 6 months, >6 months

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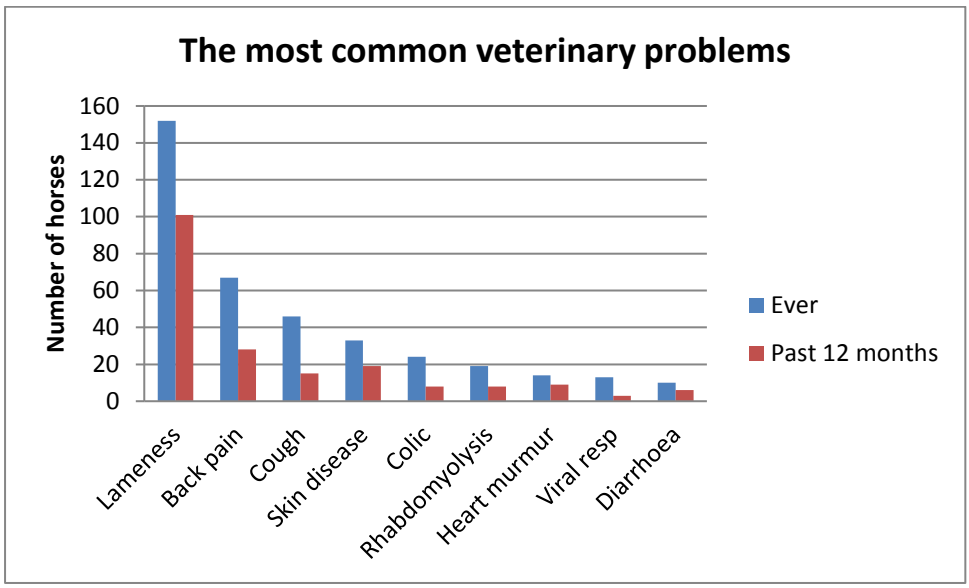
Table 3.

Descriptive results on the characteristics of riders and horses. For continuous variables the median values are provided for data that were not normally distributed, with the interquartile range (IQR) in parentheses. For normally distributed data, mean values are presented ± standard deviation.

Variables	**Responses**				
	n	Mean ± sd	Median	25th percentile	75th percentile
Rider-related					
Age (n=190)			49 years	34	58
Gender (n=190)					
Female	172 (90.5%)				
Male	18 (9.5%)				
Weight (n=182)			65 kg	60	70
Weight as % of the horse's weight (n=182)		14.4 ± 2.3%			
Horse-related					
Age (n=190)			12 years	9.9	17
Gender (n=190)					
Gelding	113 (59.5%)				
Mare	74 (38.9%)				
Stallion	3 (1.6%)				
Breed (n=190)					
Arabian	93 (48.9%)				
Arabian cross	34 (17.9%)				
Cob-type	15 (7.9%)				
Warmblood	14 (7.4%)				
Pony	7 (3.7%)				
Thoroughbred	1 (0.5%)				
Other	26 (13.7%)				
Weight (n=190)			450 kg	420	500
Height (n=190)			155 cm	150	158

Figure 1

The number of horses suffering from different veterinary problems at any time in the horse's career ('Ever') and in the 12 months preceding data collection. Viral resp: non-specific viral respiratory disease.



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